PhD SCIENCE™ TIPS FOR FAMILIES

Overview for Families

What is *PhD Science*?

PhD Science™ is a knowledge-building, phenomenon-driven curriculum. By using an observable event that can be explained or predicted—the anchor phenomenon—students have a real-world context for their learning. Students explore these compelling phenomena through observation, questioning, modeling, and investigation. The year will be divided into four units of study called modules. Each module weaves a coherent storyline of science concepts that helps students make sense of the phenomena they are exploring. Students then apply their new knowledge to an authentic situation or problem.

What will my student do in class?

Students will be working, thinking, and experimenting just like real scientists. Science will not be about memorizing facts or reading from a textbook. Instead, the science curriculum will involve hands-on investigations that allow students to develop a deep understanding of science concepts. As students uncover information about the anchor phenomenon, they will ask questions, discover evidence, generate new ideas, and come up with solutions.

Throughout the module, students generate questions about the phenomenon that will be recorded on the *driving question board*. The driving question board is a chart we will use to organize our questions and guide our learning. We will also create an anchor model and chart to visually express our ideas. These tools help us see how different concepts fit together and how our understanding of the phenomena is deepening.

Each module has opportunities for students to use the engineering design process, apply what they learned to solve real-world problems, and present their ideas. For example, in a module on energy, students will design their own light-generating device.

Discussion and debate will be part of many lessons, as students will state and defend their claims with evidence and ask questions about others' claims. At the end of each module, students will participate in a Socratic Seminar that focuses on the importance of questioning. During the seminar, students will be presented with a rigorous question that encourages them to think critically and apply their learning from the module.

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What will be different?

If you stop by the classroom during science instruction, you won't see students answering questions from a textbook or listening to a lecture. Instead, you'll find students in small groups discussing ideas, doing experiments, or reporting their findings. *PhD Science* lessons are designed to allow students to drive their own learning. Students uncover key concepts by actively engaging in science and engineering practices. They read high-quality, age-appropriate books in class that spark curiosity, introduce phenomena, and support the development of scientific understandings. Further, students document their learning in a Science Logbook that allows them to reflect, review, and track how their knowledge has progressed.

How is science connected to other disciplines?

All *PhD Science* modules make connections across science fields and academic disciplines. The curriculum highlights connections to math, literacy, and history so students can practice using the interdisciplinary approach necessary for real-world tasks. For example, in a module about Earth's features, students read historical accounts of the exploration of the Grand Canyon and use world maps to better understand where different land features are located. In addition to cross-curricular connections, all modules have lessons devoted to the application of concepts. In these lessons, students apply science and engineering practices to solve an authentic problem.

How can I help?

With each module you will receive a Family Tip Sheet that outlines the module concepts and includes ideas on how you can support your student at home. The goal of these suggestions is to help students see science everywhere and not just at school. Talking about science, watching science videos, or visiting a museum, park, or zoo are all ways to support your student's learning. For more information about what you can do to help facilitate your student's understanding of science, visit *NSTA Science Matters: Tips for Busy Parents* at https://www.nsta.org/sciencematters/tips.aspx.

Is there homework?

PhD Science modules have informal homework assignments to reinforce learning and connect students' understandings to their everyday lives. These assignments often include ideas to discuss with family members or questions that prompt a simple exploration. Students are encouraged to report their findings to the class.

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How are students assessed?

Student learning is assessed in informal and formal ways. Through questions and classwork, students will be informally assessed. At the end of the module, tasks to measure learning include a science or engineering challenge, an End-of-Module Assessment, and the Socratic Seminar. The balance of ongoing and cumulative assessments allows instruction to be adjusted throughout the module to ensure that students are progressing.

What will my student study in Level 4?

Module	Title	Anchor Phenomenon
1	Earth Features	Formation of the Grand Canyon's Features
2	Energy	Windmills at Work
3	Sense and Response	Elephants Sensing Distant Rainstorms
4	Light	Visibility of and Communication to Howland Island

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Level 4 Module 1: Earth Features

CONTENT OVERVIEW

ANCHOR PHENOMENON: Formation of the Grand Canyon's Features

Essential Question: **How did the Grand Canyon's features form?**

Guided by the story of one of the Grand Canyon's early explorers, John Wesley Powell, we will study this fascinating place and how it can help us understand Earth's past.

CONCEPT 1: Rock Layers

Focus Question: **What do Earth's rock layers reveal?**

Identifying and labeling the layers of the Grand Canyon helps us make inferences about past environments.

CONCEPT 2: Weathering and Erosion

Focus Question: **How are Earth's rock layers uncovered?**

Conducting weathering and erosion experiments helps us understand how the Grand Canyon formed and how these processes shape Earth's surface.

APPLICATION OF CONCEPTS: Reducing Damage Related to Erosion

Using the engineering design process, we will design a structure to protect a home from erosion.

CONCEPT 3: Patterns in Features and Processes

Focus Question: **How do canyons around the world form?**

Using maps to research land features found near canyons helps us understand how canyons form.

CONCEPT 4: Human Interactions with Earth

Focus Question: **How do humans interact with Earth's features and processes?**

Studying dams helps students learn how humans harness energy and change Earth's features.

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SUPPORTING OUR CLASSROOM

If you have any of the items listed, please consider donating them to our class to use in our science investigations.

- Clear plastic cups (9-ounce)
- Craft sticks

SUPPORTING YOUR YOUNG SCIENTIST AT HOME

ONGOING CONVERSATIONS

Support science learning at home by having conversations about Earth's features. Here are some suggestions to get you started:

- Talk about land and water features in your area, places that you have visited, or places you would like to visit.
- Notice how the landscape changes after a rainfall and look for erosion. Consider comparing how the Grand Canyon formed to a hole in pavement that keeps getting bigger over time.
- Discuss the different ways humans have changed the landscape to meet transportation, housing, or other needs.

ACTIVITIES

These activities support and extend the learning going on in the classroom:

- Help your student start a rock collection. Consider using a field guide to classify the rocks you find.
- While walking or driving, ask your student to notice and describe land and water features.
- Visit a nearby dam or related website and discuss a dam's purpose.
- Help your student plan a visit to an interesting land feature in your area. Take pictures or draw a sketch to capture the details.

BOOKS

Local libraries are a great resource for fiction and nonfiction books related to Earth's features. Browse the library catalog or start with these suggestions:

- *Grand Canyon* by Jason Chin
- *Mountains* by Seymour Simon
- *Finding Out about Hydropower* by Matt Doeden

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WEBSITES

Keep the learning going about Earth's features by exploring these internet resources:

- See short videos about the Grand Canyon when you visit this National Park Service website: https://www.nps.gov/grca/learn/photosmultimedia/grand-canyon-in-depth.htm.
- Learn more about the fossils in the Grand Canyon when you visit this National Park Service website: https://www.nps.gov/grca/learn/nature/fossils.htm.

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Level 4 Module 2: Energy

CONTENT OVERVIEW

ANCHOR PHENOMENON: Windmills at Work

Essential Question: **How do windmills change wind to light?**

Learning about windmills helps us understand how energy can be transformed and transferred. In the book, *The Boy Who Harnessed the Wind* by William Kamkwamba and Bryan Mealer, we see a great example of solving a problem by using engineering.

CONCEPT 1: Energy and Its Classification

Focus Question: **What is energy?**

Building models of windmills helps us understand how they work. Hands-on energy stations allow us to observe and classify energy.

CONCEPT 2: Energy Transfer

Focus Question: **How does energy transfer from place to place?**

Experiments with speed and collision show us how energy is transferred.

CONCEPT 3: Energy Transformation

Focus Question: **How does energy transform?**

After exploring how energy is transformed from one type to another, we can apply this understanding to model generators and windmills.

APPLICATION OF CONCEPTS: Construct a Device to Transform Energy

Imagining that we are without power after a flood, we will use materials from the classroom and home to build a device to harness energy.

SUPPORTING OUR CLASSROOM

If you have any of the items listed, please consider donating them to our class to use in our science investigations.

- Materials needed for our engineering challenge (boxes, paper towel rolls, paper plates, skewers, straws, aluminum foil, and other similar household items)

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SUPPORTING YOUR YOUNG SCIENTIST AT HOME

ONGOING CONVERSATIONS

Support science learning at home by having conversations about energy topics. Here are some suggestions to get you started:

- Talk about ways you use energy. Consider energy use in specific rooms of your home or energy use at different times of the day.
- Classify energy in your home by using categories such as electric current, sound, heat, and light.
- Talk about the relationship between speed and energy. For example, see how wind speed affects a pinwheel. This also relates to wind and windmills.
- Ask about a problem your student noticed and what could be invented or done to solve the problem like William Kamkwamba did in *The Boy Who Harnessed the Wind*.

ACTIVITIES

These activities support and extend the learning going on in the classroom:

- Have your student compare energy bills (electric, gas, etc.). Talk about when and why the bills may be higher. Some utilities even have online energy audits that your student could use to find ways to save money on energy bills.
- Help your student take apart a flashlight or other small object that uses energy. Draw a sketch of how the object works, and research to find out if that explanation is correct. Always use caution when handling these objects.
- Find more stories about young people like William Kamkwamba who solved a problem.

BOOKS

Local libraries are a great resource for fiction and nonfiction books related to energy. Browse the library catalog or start with these suggestions:

- *Finding Out about Hydropower*, Matt Doeden
- *Wind Turbine Services Technician*, Wil Mara
- *Feel the Wind*, Arthur Dorros

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WEBSITES

Keep the learning going about energy by exploring these internet resources:

- Visit https://www.eia.gov/kids/ to learn more about energy topics such as energy sources, history of energy, and using and saving energy.
- Visit https://climatekids.nasa.gov/menu/energy/ to explore games and articles about energy.

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Level 4 Module 3: Sense and Response

CONTENT OVERVIEW

ANCHOR PHENOMENON: Elephants Sensing Distant Rainstorms

Essential Question: **How do elephants sense rainstorms from more than 100 miles away?**

Studying how animals detect information helps us learn how they use their senses and respond. Investigating sound waves and vibrations helps us understand one way that animals and plants receive information.

CONCEPT 1: Sensory Structures

Focus Question: **How do animals receive information about their environments?**

Through the use of Sense Stations and other activities, we discover that animals have sensory structures to help them receive a variety of information about their environments.

CONCEPT 2: Sensing Waves

Focus Question: **How does information move across a distance?**

Studying waves helps us understand that they are regular patterns of motion that transfer energy across a distance. We discover that animals' touch and sound receptors detect vibrations from waves.

APPLICATION OF CONCEPTS: Sensory Models

We design and carry out investigations to explore how information travels through ground vibrations.

CONCEPT 3: Response

Focus Question: **How do animals respond to information about their environments?**

Observing animals' behavior shows us how animals receive and process information to guide their actions.

EXTENSION OF CONCEPTS: Responding to the Environment

Applying our knowledge of animal sense and responses, we explore how plants respond to their environment.

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SUPPORTING OUR CLASSROOM

If you have any of the items listed, please consider donating them to our class to use in our science investigations.

- 3-ounce paper cups
- Shoeboxes

SUPPORTING YOUR YOUNG SCIENTIST AT HOME

ONGOING CONVERSATIONS

Support science learning at home by having conversations about sense and response topics. Here are some suggestions to get you started:

- Talk about how your senses help you get information.
- Share examples of animals sensing information humans cannot. For example, a dog might notice someone approaching a door before there is a knock.
- Think of times when your senses have been altered, such as a cold that kept you from smelling your food. How did it affect your other senses, for example, your sense of taste?
- Discuss the ways that your senses help you make decisions. For example, consider how people use their senses to determine whether it is safe to cross a street.

ACTIVITIES

These activities support and extend the learning going on in the classroom:

- Observe animals and notice how they use their senses and respond to their environments. This could be done with pets, animals near your home, at a zoo, or even by watching a nature program. Remember to always be careful while observing wild animals or unfamiliar pets.
- Experiment with your senses. Try closing your eyes and naming sounds or try tasting foods with your eyes closed or nose pinched.
- Explore how sound travels through materials such as PVC pipe, cardboard tubes, or water.

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BOOKS

Local libraries are a great resource for fiction and nonfiction books related to sense and response. Browse the library catalog or start with these suggestions:

- *Amazing Animals: Cheetahs* by Kate Riggs
- *Walk with a Wolf* by Janni Howker
- *The Elephant Scientist* by Caitlin O'Connell and Donna M. Jackson

WEBSITES

Keep the learning going by exploring these internet resources:

- Visit the BBC's Super Senses website (https://www.bbc.co.uk/programmes/b04fhp70) to explore the different ways animals use their senses.
- Visit Ask a Biologist from Arizona State University (https://askabiologist.asu.edu/explore/senses) to compare our senses of hearing and touch with what we learned about elephants' senses.

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Level 4 Module 4: Light

CONTENT OVERVIEW

ANCHOR PHENOMENON: Visibility of and Communication to Howland Island

***Essential Question:* Why didn't Amelia Earhart complete her journey?**

Guided by the history of Amelia Earhart's fatal last flight, we explore how light and the physical properties of objects affect what we see and how we communicate across distances.

CONCEPT 1: Sight

***Focus Question:* How does light affect what we see?**

Using mirrors and shadow boxes helps us explore how light reflects off objects and enters our eyes.

CONCEPT 2: Physical Properties of Objects

***Focus Question:* How do an object's physical properties affect how we see it?**

Identifying patterns in how objects reflect light builds our understanding that an object's physical properties, such as texture and color, affect how we see it.

APPLICATION OF CONCEPTS: Making Howland Island More Visible

We develop, build, and test a solution that makes Howland Island and its runway easier to find. We use our understanding of light, sight, and the physical features of Howland Island to guide our work.

CONCEPT 3: Communication

***Focus Question:* How can we communicate effectively across a distance?**

Studying radio signals, infrared light, and Morse code helps us identify the benefits and challenges of communicating effectively across a distance.

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SUPPORTING OUR CLASSROOM

If you have any of the items listed, please consider donating them to our class to use in our science investigations.

- Construction paper (especially blue and green)
- Craft sticks

SUPPORTING YOUR YOUNG SCIENTIST AT HOME

ONGOING CONVERSATIONS

Support science learning at home by having conversations about light, sight, and communication. Here are some suggestions to get you started:

- Share stories about when too much light or too little light made it difficult to do something.
- Share stories about when the color of something made it difficult to see.
- Talk about how you use communication and navigation technology, such as a cell phone or GPS, in your everyday life. What do you think people used before these technologies existed.

ACTIVITIES

These activities support and extend the learning going on in the classroom:

- Look for complex shadows, such as shadows caused by multiple light sources shining on an object. Try drawing a model that explains how the shadows are made.
- Observe the changes in light during the day and notice how objects and shadows look different throughout the day.
- Visit a body of water, such as a pond, lake, river, or ocean, or create a body of water in your sink. Look at the water from different perspectives (close, far, low, high), and draw a model of each perspective.
- Choose a technology that you use for communication or navigation, such as texting or GPS, and give it up for a day. How does it impact your day? What can you use instead?

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BOOKS

Local libraries are a great resource for fiction and nonfiction books related to light, sight, and communication. Browse the library catalog or start with these suggestions:

- *Amelia Lost: The Life and Disappearance of Amelia Earhart* by Candace Fleming
- *Six Dots: A Story of Young Louis Braille* by Jen Bryant
- *An Eye for Color: The Story of Josef Albers* by Natasha Wing

WEBSITES

Keep the learning going about light, sight, and communication by exploring these internet resources:

- Learn about the science of light and how to protect our night skies at the National Park Service website (https://www.nps.gov/subjects/nightskies/index.htm).
- Get to know Amelia Earhart's story when you visit the Library of Congress website (http://www.americaslibrary.gov/aa/earhart/aa_earhart_subj.html).
- Read more about color blindness at the National Eye Institute website (https://nei.nih.gov/learn-about-eye-health/eye-conditions-and-diseases/color-blindness).

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